Technical Specifications for purchasing Motion based Light Motor Vehicle Driving Simulator for BMTC

1 SCOPE OF SUPPLY:

a) The scope of supply shall include design, manufacture, Supply, installation, Testing and commissioning of 'Light Motor Vehicle Driving Simulator' within a period of nine months, followed by warranty maintenance (comprehensive warranty of 36 months from date of commissioning).

b) Post Warranty Maintenance thereafter for 60 months for identified hardware, software and all facilities of simulators for training Light Motor Vehicle (LMV) drivers on different variants of Cars/ Jeeps as per the specifications given in the tender document**.**

c) Driving Simulator should be capable of supporting the existing and future technology LMV's like Euro-6/ BS-VI or higher norm petrol or diesel engine cars, Electric cars or CNG cars, etc.,

d) The bidder should provide complete documentation for the system supplied and its maintenance along with spare parts catalogue for all subsystems, software, facilities, training courses, etc.

e) The bidders shall provide necessary Training on use of the Simulator, an operating manual in English (three sets per simulator) giving complete details of the system along with schematic diagram and instructions, to the purchasing authority, including the instructors and nominated officers.

f) Bidder shall provide the simulator with a capability of performing minimum of 12 hours per day training sessions.

g) Each simulator will consist of the following:

SN	Description	Qty.
	List of concomitant items:	
1.	Driver Training Station (hardware)	1 No.
2.	Instruction Station (hardware)	1 No.
3.	Observer Station (hardware)	1 No.
4.	Software for simulator	1 No.
5.	Motion system	1 Set
6.	Computer	1 No.
7.	Printer	1 No.
8.	UPS for computers	1 No.
9.	Maintenance spares required to ensure availability of simulator.	1 Set
10.	User's Manual	1 Set
11.	Help Center / Technical Support Information	1 No.
12.	Complete documents for maintenance and spare parts	1 Set
13.	Any other accessory considered essential for the operation of the simulator to meet the purpose and capability	

General Requirements

1. The Driver Training Environment should contain Computer animation based theoretical training module and Simulator based virtual training environment
2. The simulator cabin should replicate the form and function of most commonly used LMV variant on Indian roads with the choice of a vehicle model shall be provided as a configurable parameter.
3. 6 degree of freedom (DOF) motion platform should be made available to Surge (Forward/ Backward), Heave (Up/ Down), Sway (Left/ Right), Pitch, Roll, Yaw motions to simulate Equipment is to be provided with Electro Mechanical platform.

	4. The simulator cabin should include CCTV camera for monitoring the driver's action. 5. The simulator cab should have a microphone for recording the sound within the cabin during a simulation. 6. The Field Of View (FOV) for the vision system should encompass the normal FOV of the driver in the seated position in the real cabin.
	DETAILS FOR THE SCOPE OF SUPPLY INCLUDE THE FOLLOWING:
A	**PHYSICAL SPECIFICATION OF SIMULATORS** The sections of this chapter specify the main characteristics required by the physical elements (hardware) of a driver training simulator. Firstly, the driver station will be specified, followed by that of the instructor.
1	**Driver Training Station** The driver station or training station (TS) will consist of the following physical elements: • Driver's Cabin • Visualization system • Motion Platform (Motion Cue Effects). • Web Cam • PC rack Each element is described below:
1.1	**Driver's Cabin:**
1.1.1	a) In order to achieve the greatest immersion possible, the driver's cabin (the place where the driver/student comes in contact with the simulator) be built up on **OEM's LMV cabin of Maruti/ Mahindra/ Tata** with controls/ functions to be fully activated and simulated. The LMV model will be as per the requirement of BMTC. b) Entire Driver's cabin is under Simulation (on motion based platform). c) The Driver cabin should be well ventilated to dissipate the heat generated from the LED panels. d) The driving station compartment dashboard shall incorporate all types of equipment as available in the vehicles, including air vents. e) The LMV cabin shall include at least the following real elements, typically of a LMV.
1.1.2	Real driver's seat with the following (mechanical and/or pneumatic) adjustment options: • Longitudinal position • Seat height • Backrest tilt The above adjustments similar to that of a LMV (Car/ Jeep).
1.1.3	Vehicle Ignition/ Stop key should be physically present like in LMV.
1.1.4	a) The Steering wheel shall be real and will include an adjustment function for its position, both in height and tilt for the driver's comfort, similar to that in LMV. b) The Steering movement should be in such a way that, before switching on the ignition, the steering should be stiff/ tight and hard to turn and after turning on, the steering should be smooth enough according to the model selected by the Driver in the Driving Simulator, which should be similar to that in a LMV.
1.1.5	Four press buttons to open/close powered windows, two powered windows for Driver and Co-driver should be physically present like in a LMV.
1.1.6	Left indicators, lights and windscreen wiper lever.
1.1.7	Continuous braking and gear shifts should comply with as per LMV's OEM.
1.1.8	a) Single Gear shifting lever capable of doing 5/6-speed manual shifts plus reverse, or in sequential mode with the functionalities and features of each vehicle that will be simulated and option of Automatic-Manual transmission & Fully Automatic transmission to be provided.

	b) Re-fittable gear lever could be provided for the simulator in line with the LMV's of different OEM. c) The smoothness/ tightness in shifting of gears shall be similar to that as LMV.
1.1.8a	**Vehicle and road Conditions** : Initial conditions such as % of LMV load in empty condition and full load condition and its distribution, ABS system, ASR, ESP, tire condition, air pressure etc., all may be configured. Also conditions like new LMV on a new road and on a degraded road, an older LMV on a new road and on a degraded road need to be configured.
1.1.8b	**Malfunctions**: The driver should also learn to read to the possibility of a flat tyre, drop in air pressure, drop in oil pressure, engine overheating, ABS system fails, fuel loss, etc…
1.1.9	Direction selector with buttons (N, D, R) for automatic shifting (wherever applicable).
1.1.10	**Environmental Sound Effects** A high fidelity aural cue (surround sound) system should be provided to give realistic dynamic sounds for continuous and asynchronous vehicle sounds to enhance realism. Typical sound includes engine (varies with revs), road noise, squeal of tires with traction varying with terrain and load, air brakes as appropriate and collisions with vehicles and other objects such as signs, road markers, trees and buildings. sounds to enhance realism.
1.1.11	Autonomous vehicle (AV) Doppler effects and environmental sounds should also be simulated. The sound modelling shall simulate the Doppler shift effects and Volume attenuation with distance effect and the audio environment associated with the operation of the car like Engine sounds (in proportion to gear ratio), Braking sounds, etc....
1.1.12	a) Accelerator, brake and clutch pedals (not actuated). b) The arrangement of foot controls in the simulator such as Accelerator, Brake and Clutch Pedal shall be as per the Automotive Industry Standards and the movement of foot controls should feel realistic as good as felt in LMV's of different OEM's. c) An adjustable foot rest should be made available for the Driver near the pedals on which the driver can rest his foot, so as to prevent fatigue.
1.1.13	Parking brake lever should be physically present like in LMV.
1.1.14	Controls for various functions: • Light controls (position, dipped beam, main beam) • Fog lamps • Emergency switch (all indicators ON) • Horn • Circuit breaker (safety system that cuts electrical power in case of accident)
1.1.15	Indicators of various kinds on TFT screen display integrated into the dashboard. There is a display for each vehicle. • Speedometer • Tachometer • Digital engaged gear indicator • Fuel level • Air pressure in air tanks • Coolant temperature • Pilots to indicate activations, alarms, faults, etc., such as direction indicators, dipped beam, main beam, retarder on, etc.
1.1.16	Taking into account that the seat is a simulation element, additional equipment related to the following aspects should be installed: • 5.1 Stereo sound system (make of Sony/ Bose/ JBL/ Yamaha) capable of providing typical driving sounds: aerodynamic and tyre noise, sounds of controls and indicators (horn, reverse beep, etc.), pneumatic system sounds, environmental noises, etc. • Suitable equipment so that the steering wheel is capable of transmitting the natural

	torques when driving around a curve, manoeuvring, breakdowns, etc., Force feedback steering wheel linked to driving activity eg. stationary wheel scrub, speed dependant centering, wheel vibration. General noise level of the traffic and other elements of noise to be incorporated. • All additional sensors and electronics required. • Emergency push button accessible by the driver, so all actions on the TS can be stopped when needed (steering wheel and platform). • Incorporated microphone for communication with the instructor.
1.1.17	Simulation of Docking of LMV (feature be provided only on demand by BMTC).
1.2	**Visualization System of Simulator**
1.2.1	From the driver's seat, the Driver/Student shall be able to see a virtual environment in which he will drive. The visualization system created around the driver's seat shall comply with the following parameters: • The vision includes the following environmental effects: o Rain o Fog o Haze o Sun glare o Cloud cover o Water on road o The vision is capable of displaying various environments including city, sub-urban, highway and rural terrain. • Environmental effects behave in a manner consistent with the scene. • The vision includes dynamic shadows consistent with the time of day. Night time simulation also be included • The vision system is able to simulate different seasonal effects e.g. winter, summer, autumn with appropriate visualisation of Vegetation (trees etc.), Clothing (passengers / pedestrians etc.), along with wind strength effects • The special animations and effects like fire, smoke, etc... to be included
1.2.2	It should allow the use of distance references in a sufficiently precise way.
1.2.3	It must provide a horizontal visual field of 120 Degree (FOV).
1.2.4	Regarding the performance of the visualization system, the image shall be refreshed at frequencies in the region of min. 50 Hz to provide smooth evolutions.
1.2.5	A visual system will be used for brightness and contrast, with a minimum 2K resolution per screen.
1.2.6	1. The audio-visual system will consist of screens and audio capability to simulate with the aid of screen size suitable to that of a selected LMV model front windshield screen, of minimum (2560x1440) 2K resolution LED TV (curved is optional) or better technology type screens, to give realistic experience of an LMV. The audio visual system shall be a part of platform. 2. A Virtual Vehicle Interface (VVI) has an interactive screen to allow the driver to access and control components of the vehicle that are not part of the simulated driving cab is a preferable option. VVI must include an external 24” touchable screen in order to make it possible for the trainee to access the virtual panel outside the driving cabin to check vehicle status or to carry out fault rectifications. 3. The LED TV's or better technology screens provided to Simulator should be equipped with suitable technology or arrangements sensitive enough to avoid eye strains, when

<table>
<tr><td></td><td>sat for longer duration using the simulator.</td></tr>
<tr><td>1.2.7</td><td>The images from the rear view mirrors system will be integrated within the system and Rear view mirrors shall be simulated. (Placing rear view mirrors physically and simulating the images in the mirror is optional)</td></tr>
<tr><td>1.3</td><td>Motion Platform (Motion Cue Effects)</td></tr>
<tr><td>1.3.1</td><td>A six (6) degree of freedom (DOF) motion platform should be made available to Surge (Forward/ Backward), Heave (Up/ Down), Sway (Left/ Right), Pitch, Roll, Yaw motions to simulate Equipment is to be provided with standard electric motion platform with brief nomenclature as follows:
<table>
<tr><td>Architecture</td><td>6 DOF Motion Platforms</td></tr>
<tr><td>Actuation</td><td>Electric</td></tr>
<tr><td>Payload</td><td>As per the LMV model suggested by BMTC</td></tr>
<tr><td>PC Interface</td><td>USB or Ethernet</td></tr>
<tr><td>PC – Controller Update</td><td>Min. 100 Hz</td></tr>
<tr><td>Power Requirements</td><td>220 – 240 VAC, 1ϕ, 25 amps</td></tr>
<tr><td>Angular Axis</td><td>Displacement / Velocity / Acceleration</td></tr>
<tr><td>Independent Surge (disp./ vel./ accel.)</td><td>Min. ±65mm, ±100mm/s, 0.3G</td></tr>
<tr><td>Independent Sway (disp./ vel./ accel.)</td><td>Min. ±65mm, ±100mm/s, 0.3G</td></tr>
<tr><td>Independent Heave (disp./ vel./ accel.)</td><td>Min. ±65mm, ±100mm/s, 0.3G</td></tr>
<tr><td>Independent Yaw (disp./ vel./ accel.)</td><td>Min. ±15°, ±15°/s, ±150°/s²</td></tr>
<tr><td>Independent Pitch (disp./ vel./ accel.)</td><td>Min. ±10°, ±15°/s, ±150°/s²</td></tr>
<tr><td>Independent Roll (disp./ vel./ accel.)</td><td>Min. ±10°, ±15°/s, ±150°/s²</td></tr>
</table></td></tr>
<tr><td>1.3.2</td><td>Acceleration, Pitching angle and braking.</td></tr>
<tr><td>1.3.3</td><td>Roll angle: centrifugal force when bending.</td></tr>
<tr><td>1.3.4</td><td>Vertical motion: uneven terrain.</td></tr>
<tr><td>1.3.5</td><td>The motion platform will be covered to prevent any external element being placed underneath and thus ensure perfect operation of the platform.</td></tr>
<tr><td>1.4</td><td>Web Cam</td></tr>
<tr><td>1.4.1</td><td>A closed circuit television (CCTV) should be able to capture the images of the Driver/ student sitting in the Driver cabin. These images will be displayed live on the instructor's station during the sessions. This enables the instructor to monitor the student from a distance at the instructor’s operator system. He can monitor the student’s face and hand position on the steering wheel, which enables the reinforcement of proper scanning and hand placement requirements.</td></tr>
<tr><td>2</td><td>Instructor's Station</td></tr>
<tr><td>2.1</td><td>Instructor Station Hardware
The instructor's station must be capable of controlling up to 3 Driver Stations and should have at least the following components:
• Open-fiber glass cabin
• Four display screens to supervise student‘s simulation (LED TV/ Monitor screens of reputed brand , Minimum:24", 2k resolution, 180 hz)
▪ 1 no. Touchable Screen for the Instructor Station‘s control application.
▪ 1 no. Screen for the Driver camera to see the road scenario
▪ 1 no. Screen for Real driver cabin view through CCTV Monitoring
▪ 1 no. Touchable Screen for Virtual driver dashboard controls</td></tr>
<tr><td>2.1.1</td><td><u>Instructor Station‘s/ Simulation control screen LED</u>:
a) Display of at least four 24" LED/ Monitor with touch screen showing the simulator's</td></tr>
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<table>
<tr><td></td><td>management software application, in which the instructor will have the following:
• Real time monitoring of the status of all controls (steering wheel, pedals, gears, etc.), and indicators(speedometer, tachometer, fuel level, air pressure, etc.) of the TS.
• Traffic status and road map monitoring around the current position of the simulated vehicle.
• Tools for launching, faults, incidents, changes in environmental conditions, etc.
• Global parameters of the session (distance travelled, average speed, simulation time, road gradient, consumption, etc.).
b) The LED touch screen provided to simulator should be equipped with suitable technology or arrangements sensitive enough to avoid eye strains, when sat for longer duration.</td></tr>
<tr><td>2.1.2</td><td><u>Driver camera LED screen</u>:
Display of at least 24" LED to allow the instructor to see student both in the real world and in the simulated world. To do so, this display will show both the student's webcam image and the simulated scene where the exercise is taking place from eight different viewpoints. The selection of the virtual camera view is made from the instructor's application interface and allows the instructor to see the scene from outside the vehicle to analyse, for example:
• Manoeuvres tracking
• Outside perspective to observe the vehicle swings
• Traffic around the vehicle</td></tr>
<tr><td>2.1.3</td><td><u>CCTV Captured real driver cabin viewing LED Screen</u>:
A monitor will capture the images of the student. These images captured by closed circuit television (CCTV) will be displayed live on instructor's station LED screen, which enables the instructor to monitor the student from a distance.</td></tr>
<tr><td>2.1.4</td><td>Microphone for communication with the student.</td></tr>
<tr><td>2.1.5</td><td>Printer to obtain printed reports of each simulation session.</td></tr>
<tr><td>2.1.6</td><td>Wireless keyboard and mouse for a clean desk without cables.</td></tr>
<tr><td>2.2</td><td>Observer station
Observer station is used to observe the trainee’s activities by the next trainees, for the scenario given by the instructor. Observer station consists of 4 no. of 24” LED TV Display (1920x1080) are used to display the scenario to the observing trainees. The views displayed
▪ 1 x Screen for the Driver camera screen to see the road scenario
▪ 1 x Screen for the Instructor Station‘s control application.
▪ 1 x Screen for Real driver cabin view through CCTV Monitoring
▪ 1 x Screen for Virtual driver dashboard controls</td></tr>
<tr><td>2.3</td><td>Technical station
Technical station comprise of PC rack which houses Instructor and visual system computers, network switch etc., The computer system shall be High End Rack Mounted Computers with the configuration shall be as under of reputed brand (Intel, AMD, MSI, Samsung, Corsair, WesternDigital, CoolerMaster, Logitech, etc.,) :
<table>
<tr><td>Processor</td><td>Intel core i7-14700K or better</td></tr>
<tr><td>OS</td><td>Windows 11 Pro (lifetime license)</td></tr>
<tr><td>GPU</td><td>NVIDIA, Minimum: 16 GB, GDDR7</td></tr>
<tr><td>RAM</td><td>Minimum: 32 GB, DDR5, CL30, 6000 Mhz</td></tr>
<tr><td>Storage Memory</td><td>Minimum: 2 TB, SSD, Gen4 NVMe</td></tr>
<tr><td>Motherboard</td><td>Suitable to support all the above components</td></tr>
<tr><td>PSU</td><td>Suitable to support all the above components</td></tr>
<tr><td>Cabinet</td><td>Suitable with proper air ventilation, cooling</td></tr>
<tr><td>Keyboard, Mouse</td><td>Suitable</td></tr>
</table></td></tr>
<tr><td>3</td><td>Installation and Operation</td></tr>
<tr><td>3.1</td><td>Components</td></tr>
</table>

3.1.1	a) The simulator will be based on PC technology. The PCs should be in racks (or equivalent solution). b) The PC's provided for controlling, recording and viewing the Simulator shall be of suitable capacity enough for uninterrupted operation of simulator. c) The bidder shall upgrade the PC's as and when necessary, during the warranty period.
3.1.2	An uninterrupted power supply (UPS) system will also be included to isolate the equipment (PCs, Screens, Monitors, etc.) from possible power fluctuations for a minimum time of 1 hr and safely shut down the simulator until power is restored. Thus, equipment is protected against possible failure due to power grid instabilities.
3.1.3	The system wiring should be hidden in the driver's seat and in the rack. The connections to be made between these elements must be properly channelled, so that the final installation does not present loose wires.
3.1.4	Communication between all PCs should be made through an Ethernet network, with a min. 1 Gbps switch, ensuring maximum communication flow between the system PCs, even for large volumes of information.
3.2	**Installation**
3.2.1	The simulator must be able to be located in floors above the ground (for example, on the ground/ first floor), and all its components should be able to go through a 2.10 x 1.20 meter door. The floor of the classroom will be designed to withstand a distributed load of up to 400 kg/m2.
3.2.2	The maximum height of the simulator should be 3.5 meters to ensure perfect adaptation to the simulation classroom.
3.2.3	The simulator installation shall be capable of working on • 50 Hz A.C. electric supply conventional 3-pin sockets for 220V-16A. • A network connection point for equipment communication with the exterior (for remote maintenance and technical assistance).
3.2.4	**Final Acceptance**: The Bidder shall submit as part of bid, a format of the Site Acceptance Test (SAT) Plan. The format of the SAT Plan shall be approved by BMTC. Site Acceptance Test (SAT) certificate for the simulator shall be issued by consignee after installation of all system equipment at site, the successful demonstration and completion of the approved acceptance test plan and acceptance of the submitted documentation package by BMTC.
3.3	**Operation**
3.3.1	The procedure to start and shut down the system should be simple, so no IT knowledge is necessary to do so. Both start and shut down must meet the following conditions: • Maximum time to start and shut down is 2 minutes • Start and shut down must be centralized. • The procedure shall require minimum number of switches.

FUNCTIONAL SPECIFICATION OF THE SIMULATORS

B	This chapter specifies the functionality of the simulator software.
1.1	**Vehicles to Simulate** The simulation modelling shall accommodate any one of the Maruti/ Mahindra/ Tata LMV types of combinations with option for other type of LMV simulation, that are commonly seen on Indian roads.

1.1.1	To change from one vehicle to another, the maximum time of change will be 2 minutes and no hardware element should be changed with the exception of a possible shift lever or similar to minimize potential problems with the hardware in the future.
1.1.2	Realism of simulated models: Models should provide appropriate behaviour of the simulated vehicle; according to the parameter settings chosen by the instructor in the Edition Mode (see B-1.3). In general, the scope of the models must comply with at least the following aspects:
1.1.3	Adherence based on weather, road conditions, the condition of the tyres, speed, etc.
1.1.4	Acceleration and braking capacity depending on the engine power curve, type of vehicle, vehicle load, terrain slopes, wind intensity and direction, etc. Acceleration, braking and jerk rates to be captured for assessment and evaluation of driver's performance
1.1.5	Security systems (traction control, brake control, stability control)
1.1.6	Breakdowns (see B-1.6)
1.1.7	Incidents (see B-1.7)
1.1.8	Operation of all elements of the driving station.
1.2	**Instructor's Station (IS)** The instructor is the real user of the simulator. Therefore, it is essential to have a physical instructor's station or IS, from which the exercises can be created and the simulation development can be controlled.
1.2.1	The Instructor's Station (IS) is the simulator control station, from which the instructor carries out their work. It must allow for the following operations to be carried out: • Designing the simulation exercises. • Controlling the execution of the simulation sessions and their recording/replay • Playing the recorded simulation sessions. • Assessing the simulation sessions. Formats to be decided in accordance with the purchaser.
1.2.2	For this, the IS must be equipped with the necessary elements to allow the instructor a high degree of control over the simulation, including at least the following elements:
1.2.3	Monitoring of the scene, with the ability to select different viewpoints. The simulated vehicle position on the road or on the scene should be observable, as well as the position of traffic vehicles in the surrounding areas, etc. All with the possibility to switch in real time between different viewpoints or angles from which to view the scene.
1.2.4	Monitoring the driving controls and indicators so the instructor knows what use the driver is making of them.
1.2.5	Monitoring traffic status around the vehicle being driven by the student.
1.2.6	Video image of the driver.
1.2.7	Interface for control of the simulation, with the possibility of intervening by adding incidents, breakdowns, varying environmental conditions, traffic control, etc.
1.2.8	**Printer**
1.2.9	Communication system with the student.
1.2.10	Being an instructor station, the IS's ergonomics should be assessed, both from a physical and functional point of view (information layout, access, operation, etc.,)
1.2.11	Additionally, it should be designed to provide a simple interface, intuitive and friendly, so that the instructor will not need special computer skills to achieve, before long, a highly efficient management and operation of the system. (Company can train the instructor)

1.2.12	The Instructor Station application should have three operational modes: Edit Mode, Execution Mode and Evaluation Mode. These modes will allow the design and administration of exercises, the control of the simulation sessions and the follow-up and evaluation of the students in their training, respectively. There will also be a user management environment.
1.3	**Edit Mode (Exercise Planning)**
1.3.1	The Edit Mode will allow the instructor to carry out the following tasks: • Create new exercises from scratch or from exercises that already exist. • Change exercises. • Delete exercises. • Provide a learning structure based on pedagogical criteria.
1.3.2	When creating an exercise, the program will offer a number of options that the simulator should be able to emulate by using its software. Therefore, the edit parameter list defines and strongly conditions the functional scope of the system.
1.3.3	Specifically, the simulator should have the capacity to cover all the necessary functionalities for the instructor to handle the following parameters when editing exercises:
1.3.4	Selecting the type of vehicle
1.3.5	Initial conditions of the vehicle: • Load (level and distribution) • Pneumatic system pressure • Condition of the tyres • Fuel level • Possible faults or damages • Incorporation or not of security systems (traction control, brake control, stability control)
1.3.6	Initial environmental conditions: • Determining the lighting and level of cloudiness to determine aspects such as daylight level or night driving. • Level of rain or fog. • Wind direction and intensity.
1.3.7	Scene where the exercise will take place (see B-1.4): • Starting point of the itinerary to simulate • Traffic configuration (average speed, density, etc.) • Condition of the road surface (adherence and unevenness (smooth / speed breakers / pot holes / rough))
1.3.8	Programming of events during simulation (based on different criteria): • Change of weather and visibility conditions (rain, wind, fog, etc.) • Change of general traffic conditions (density and average speed of vehicles) • Breakdowns (see B-1.6) • Incidents (see B-1.7)
1.3.9	Both normal and difficult driving situations should be able to be emulated.
1.4	**Simulation Scenes (Virtual World Environments)**
1.4.1	Simulation scenes shall be drawn from an initially supplied adequately populated realistic roads and intersection database, so that driving exercises can be carried out on any type of road and with any duration. The sections to be built into the data base shall be drawn up in consultation with respective Training institute. Road types range from highway, interstate to dirt (two tracks) to gravel to paved. Blind intersections, switch backs, significant changes in

	elevations, limited sight hills, narrow bridges , 6% to 7% graded mountainous stretch, a winding canyon region and other driving hazards including vehicular and pedestrian congestion in urban limits.
1.4.2	Roads need to fulfil Indian road legislation (Bengaluru and Karnataka roads are preferable).
1.4.3	Intersections/ Junctions shall be representative of the Indian urban local Bengaluru environment (rumble strips, table top crossing, etc.). Language used for signs shall be similar to that in roads of Karnataka.
1.5	**Visual System** Visual system should fulfil following requirements:
1.5.1	The visual system should be based on latest generation PCs and incorporate graphic techniques appropriate to the type of application in question, providing the highest possible quality graphics without causing fatigue, eyestrain or other negative effects.
1.5.2	Realistic lighting and visibility conditions based on aspects such as the following: • Time of day (day time/night driving) • Driving through tunnels • Headlamps (depth of beam, on or off, etc.) • Weather conditions
1.5.3	Image corresponding to the real viewpoint of a driver from a real driving seat (including the front blind angle hiding the nearest part of the road, as well as those of the rear mirrors).
1.5.4	Correct appearance of traffic signs.
1.5.5	Smooth evolution of the image when the vehicle is in motion.
1.5.6	**Outside environment of the simulator** 1. It should provide simulation of all elements outside of the simulator vehicle 2. It should simulate typical Indian urban and rural vehicular traffic along with pedestrian traffic with an Artificial Intelligence capability. 3. The Artificial Intelligence for an entity movement should invoke collision avoidance with the simulator driving. 4. The movements of the animals like cows, stray dogs and goats, etc.... should be simulated as a part of traffic 5. It should provide intelligent and manual intersection control. 6. It should simulate passengers boarding and alighting.
1.6	**Breakdowns** One of the areas to be emphasized is training drivers to manage breakdowns. They must learn to analyse the symptoms in an orderly manner to identify the source of the problem and then assess the effect on safety and how the breakdown should be fixed.
1.6.1	To do this, the simulator must provide a sufficiently broad range of breakdowns affecting the different vehicle systems, a minimum of 15 breakdowns, such as (bidders must specify the complete list of breakdowns and include a description of symptoms and effects to be simulated for each of them): • Tyre burst • Engine and power supply breakdown. • Transmission breakdown • Breakdowns in axles, wheels and steering • Retarder Breakdowns • Pneumatic system breakdown

	• Brakes breakdown • Electric system breakdown • Suspension breakdown etc.
1.6.2	Once the student has identified the breakdown and managed it properly, the instructor can delete it and the vehicle will recover its initial condition, or the instructor will decide to maintain the breakdown to resume the session in more difficult conditions.
1.7	**Incidents** Hazard situations on the road are often marked by previous foreign elements that determine the level of care, make driving difficult and, generally, produce unusual situations that lead to a potential accident. Therefore, in order to be trained in driving situations that involve hazards and are difficult to replicate in real life, the simulator must provide a collection of incidents large enough to generate any driving situation. Driver Simulator shall be capable of educating through audio and visual warning/ alert about the precautionary measures to avoid situations like Fire incident or Accident or counter such incidents during the operation.
1.7.1	Following 15 incidents shall be provided as a minimum:
1.7.2	Presence of another vehicle (cyclist, biker, etc.) occupying part of the lane
1.7.3	Vehicle travelling at abnormally low speed
1.7.4	Vehicle travelling at abnormally low speed without any rear lights
1.7.5	Vehicle travelling in the opposite direction invading the driver's lane
1.7.6	Vehicle not stopping at a red light
1.7.7	Vehicle not stopping at a stop sign
1.7.8	Vehicle not stopping at a give way sign
1.7.9	Sudden braking of vehicle in front
1.7.10	Door of a parked vehicle opening
1.7.11	Pedestrian stepping onto the road in areas regulated or not
1.7.12	Objects on the road
1.7.13	Dog stepping onto the road
1.7.14	Unmarked hole on the road, defects on the road
1.8	**Execution Mode (Simulation Exercises)**
1.8.1	The Execution Mode should have controls to load, start, and end the simulation sessions. During these sessions, the instructor will have all the monitoring and control tools offered by the IS.
1.8.2	In addition to complete monitoring, in Execution Mode the instructor should be able to add new breakdowns and incidents to those programmed for the exercise, change the weather conditions and, in general, modify any parameter of the initial exercise definition (modification of global traffic characteristics, acting on individual vehicles in traffic, road conditions, vehicle load, fuel level, etc.)

1.8.3	Meanwhile, the student will be driving the simulated vehicle facing all the situations proposed by the instructor. For the degree of assimilation of the training to be the maximum, it is important that the level of realism observed by the student is as high as possible. In this regard, it is important that the simulator is provided with a software that includes highly advanced mathematical models, Motion sensing vision so that driver is able to see obstructed objects by head movement as it happens in the real life situation and an automatic traffic module, as well as a realistic visualization module. These aspects are addressed in the following sections.
1.9	**Vehicular Traffic Simulation** Driving exercises should be carried out in a context of traffic configurable by the instructor. In general, vehicular traffic would exhibit natural behaviour in lanes. The instructor shall have tools to generate specific situations, such as the following:
1.9.1	Different traffic densities.
1.9.2	Slow or fast traffic (different levels)
1.9.3	Generate traffic jams.
1.9.4	Introduce special vehicles.
1.9.5	Delete specific vehicle from the traffic flow (or remove them all).
1.9.6	Modify the behaviour of any vehicle on the scene: • Changing its speed • Order it to change lanes
1.9.7	Generate incidents based on offending vehicles that put the student in a dangerous situation.
1.10	**Evaluation Mode (Analysis and Evaluation of Simulations)** The Evaluation Mode must provide two functions: • Playing recorded sessions. • Evaluation of sessions.
1.10.1	Replaying a driving exercise done by a student must always be possible. This will take place through a simple interface, with controls that are familiar to the user, similar to those of a DVD player (start, pause, stop, skip, etc.) Also, it should offer the possibility of going from one recording point to another, making it easier to use timestamps that the instructor might have placed during the simulation so that those moments of the exercise considered important can be easily accessed later on.
1.10.2	The level of detail of the recording content should be the highest possible, so that instructor and student can analyze the session in the most useful and complete way possible.
1.10.3	As for the evaluation of the exercise itself, the system must be capable of providing the instructor with a first assessment of all those parameters that, being objective aspects, can be evaluated automatically. Therefore, there are two types of driving errors that should be evaluated during the simulation:
1.10.4	• Errors detected automatically by the system: speeding, breaches of the regulations, collisions, etc.
1.10.5	• Errors detectable only by the instructor: taking "unreasonable time" to identify a breakdown, dangerously approaching a lane, reckless speed approaching a curve, braking late, etc.

1.10.6	The training system software must be able to detect a large number of errors automatically, and also shall provide the information and tools necessary for the instructor to comfortably undertake the evaluation of all aspects that are more subjective and therefore cannot be automatically assessed.
1.10.7	The result of the assessment will be a combination of the two previous items and will allow a mark to be inferred that will be assigned to the student in the execution of that particular exercise, thus allowing the generation of evaluation and progress reports.
1.11	**Automatic Assessments Detected by the System** The system should be able to automatically identify the following types of errors to facilitate the work of the instructor, so they can be registered and recorded for later analysis, including at least the following (bidders should include the complete list of automatic assessments offered by their simulator):
1.11.1	Errors leading to an accident: • Overturning • Skid of front or rear axle • Collisions • Running over a pedestrian, side collisions etc.
1.11.2	Travelling errors: • Swerving into the left or right shoulder • Driving off the road • Swerving into an oncoming lane, overtaking on a continuous line • Not using direction indicators correctly
1.11.3	Errors related to signals: • Not stopping at a red light • Speeding on approaching yellow signals
1.11.4	Errors when operating the vehicle and its systems: • Accelerating in neutral with engine started • Starting/ Switching off the Engine with gear engaged condition. • Initiating the movement of the vehicle at Higher gears. • Sudden braking • Not maintaining the safety distance • Depress clutch before service brake when braking. • Turn steering wheel suddenly • When moving forward or reversing, not stopping the vehicle to engage reverse or forward gear. • Drive in neutral or when depressing the clutch. • Change gears without depressing clutch enough. • Depress accelerator pedal 75% below the green zone. • Go over the rpm red zone.
1.11.5	Errors in managing lights
1.11.6	Starting procedure errors: • Driving with hand brake on. • Driving without logging in driver ID
1.11.7	Errors related to the end of the task: • Leaving a parked vehicle without using the hand brake.

1.12	**Managing Users and Databases** User means both instructors and students. All of them will be registered in the system and conveniently organised.
1.12.1	In the case of instructors, they will have an access password and different levels of security to access certain information and/or actions.
1.12.2	In the case of students, the database will include the history of their simulation sessions and the results obtained in them, which will allow the analysis of their evolution and of the effectiveness of the training designed and reflected in the library of exercises.
1.12.3	The training system databases include not only the users but also the exercise libraries, recorded simulation sessions and evaluation reports with all results. All these elements will grow in volume as the simulator gets to be used, so this must have sufficient storage space and offer functionalities for performing backups.
C	**LEARNING PROJECT**
C-1	The IS software must allow the instructor to create as many exercises as he/she wishes, combining the parameters they have to create different driving/road situations.
C-2	The successful tender should provide training courses to prepare instructors, who will be later responsible for the use of the simulator. In short, the provision should include the implementation of a training system based on a latest generation simulator and the most appropriate learning techniques for such a tool (training planning, exercise configuration, working session organization, briefing, debriefing, etc.). The supplier should offer advanced training – both personalised training and materials. Training to be imparted in both English and Regional Language wherever necessary. Training should facilitate interactive multimedia instruction, customised curriculum/course material, simulation training, documentation and analysis. The simulator should ensure – backing procedures, space management, speed management, hazard avoidance, emergency manoeuvres, turns and intersections, pass and lane changes etc. The simulator should have the provision of replaying the entire performance of each of the trainee and generate the performance reports on customised parameters, which can be saved in the system and also should help in taking friendly printouts. It should provide options for testing the drivers in different scenarios and evaluate their levels of competence. It should evaluate by correcting the procedures and display the mistakes committed, time management, level of alertness, reaction assessment, overall score and assessment (Pass/Fail) • Can record faults, save, replay and print sessions for analysis
D	**PROJECT DOCUMENTATION** The delivery of the simulator should include the technical documentation to facilitate its optimum use. This documentation should include the following elements (some of the manuals listed below could be merged or broken down according to functionality and clarity criteria):
D-1	Instruction Manual for the operation of the simulator by the instructors.
D-2	Operation and Maintenance Manual.
D-3	List of system components, including their description, brand and serial number where applicable.

Software Features

Sl. No.	Features	Description
A)	**VISUAL ENVIRONMENT**	
1	Terrains	Simulator to have 3D visual environment covering following elements: • CITY TERRAIN: Including Commercial area, Residential area, featuring schools, parks, zebra crossings, speed breakers, flyovers etc. • HIGHWAY TERRAIN: Including tunnels, railway crossings etc. • HILL TERRAIN: Including steep turns, tunnels etc. Note: The terrains are to replicate Indian Road conditions and Traffics rules as per Motor Vehicle Act.
2	Reliance Sound Environment	Simulator to give high quality stereophonic representation of sound without clutter & capture following elements: • Starting ignition sound • Vehicle engine sound in proportion to gear ratio • Surrounding traffic noise • Horn • Rain drops • Wind shield wiper • Screeching brake sound • Indicator's ticking sound • Vehicle crash sound • Acceleration/retardation
3	Free driving in fully Immersive environment	Simulator to provide complete freedom to drive in simulated environment in different driving situations: • Normal driving situations • Hazard Perceptions (Risky situations)
4	Simulated modes / time of day	Simulator to enable driving in different simulated modes of day and night.
5	Varying traffic density	Simulated vehicle density of 150 vehicles per Km including vehicles like cars, trucks, bus, taxi, motorcyclists, auto rickshaws, cycle rickshaws and pedestrians.
6	Adverse weather conditions	Simulator to have the provision to drive/practice in adverse weather conditions and experience. • Fog drive with three different varying visibility options i.e. Low / Medium & Full visibility. • Rain drive with three different intensity of rainfall i.e. Low / Medium & High • Wind drive with three different intensity of rainfall i.e. Low / Medium & High • Dust drive with three different intensity of rainfall i.e. Low / Medium & High
7	Exhaustive	The simulation software is to be provided with elaborate database on road

Sl. No.	Features	Description
	database	and track network to ensure large and variable driving conditions so as to give driving opportunity for all possible real life and testing situations. The minimum requirements for the database are: a) Manoeuvring area: minimum of 300 square meters b) Test track : minimum of 8 kms length c) Town and suburbs: 200 kms of road (more than 70 Cross roads) d) Country road : minimum of 12 kms e) Small town road : minimum of 5 kms f) Mountain road : 5 kms
8	Advanced vehicle dynamic module	The equipment should be provided with high end vehicle dynamic module so as to achieve true vehicle behaviour. Equipment may be calibrated on following parameters for real life simulation effect: a) manoeuvrings: Reversal & turning skills b) Different types of tyre pressures and conditions: Provided with choice of normal tyre pressure, high pressure, low pressure, worn out tyre conditions etc. c) Road condition: Provided with choice of having dry and wet road conditions (with road humps) to experience skidding effect. d) Vehicle load options: Driving experience with and without passenger load. e) Reverse Parking f) Driving in the Up gradient g) The vehicle model should simulate the dynamics of the vehicle movement like Gravitational effects, Rolling resistance, etc.... h) Vehicle loading effects should synchronises with the dynamics i) The model shall simulate the braking systems, control and most common faults of the vehicle j) The model should simulate the vehicle functionality required to execute the fault identification and to calibrate the controls
9	Drive replay mode	Simulator should provide video replay of full drive as undertaken by the driver so as to see mistakes committed by the driver. This feature should be available for all scenarios of training and assessment: a) The replay mode should be user friendly for fast review. It should have Fast Rewind, Fast Forward, Stop, Pause features. b) Different angle of view should be available: c) Aerial (adjustable forward and backward focus) d) 360 degree rotation around the trainee vehicle e) Review should have option of reviewing drive from inside the vehicle, as well as from outside to see the trainee vehicle and the surroundings, including other vehicles on a real time video. f) At the end, replay option should help learners to monitor/review his/her progress based on following parameters: i) Driving time

Sl. No.	Features	Description
		ii) Driven distance iii) Total fuel consumption iv) Total CO_2 emission v) Average speed vi) Average rpm vii) Average CO_2 emission viii) Average fuel consumption ix) Mileage x) Graphical depiction
10	Progressive training curriculum	Progressive training curriculum should help learners in acquiring basics to advanced driving skills in user friendly manner as depicted below: a) Training curriculum should comprise of detailed chapters/training lessons on basic to advanced driving skills. b) Video demonstration on skill explanation in each chapters/ lessons is to be provided. c) Guiding aid to learners / novices in each practice session should be provided with clear audio & written messages. d) Assessment/review on learned skills after completion of each chapter. e) Test/review of previous learning before starting learning in a new chapter.
11	Detailed training curriculum will have following modules:	a) Training module for beginners b) Training module for advanced learning c) Risk awareness module d) Night driving module e) Emergency braking & response time module f) Eco driving module g) Free driving module h) Assessment module (Optional & customized)
12	Training module for beginners	This module should cover training chapters for beginners on following areas of skill explanation. Each chapter involves detailed training lessons & practice sessions helping learner to acquire basic driving skills. Some of the chapters on progressive learning are as follows: a) Learning vehicle pre-checks b) Starting off c) Learning steering controls d) Learning gear changing e) Learning to manoeuvre at slow speed f) Learning precision on acceleration g) Learning reverse parking h) Learning driving in the up gradient i) Learning driving in down gradient j) Leaning driving in S – shape in both forward and reverse direction
13	Training module for	This is a stage further to the progressive curriculum for beginners. Curriculum under this section should cover training lessons on the following

Sl. No.	Features	Description
	advanced learning	aspects of driving training: a) Training lessons on checking your blind spot in different conditions. b) Training lessons on merging from a parking space. c) Training lessons on getting into an acceleration lane. d) Training lessons on leaving the road into parking. e) Training lessons on exiting the road using an exiting ramp. f) Training lessons on moving through intersections, changing directions and stopping yielding right of way. g) Training lessons on crossing the intersections, traffic lights & multiple lanes in following conditions. h) Training lessons on negotiating intersections at traffic circles. i) Training lessons on moving through narrow lanes & oncoming traffic. j) Training lessons on overtaking & being passed by surrounding traffic. k) Should give evaluation / review at the end.
14	Risk awareness module	Simulator should cover following multiple driving scenarios giving learner an opportunity to drive in different risky situations (Unexpected calamities, Landslides, Floodwater, Foggy atmosphere, Ice fallen roads, etc.,) (feature be provided only on demand by BMTC) : a) Risky situations predicting behaviour of driver. b) Mental models of driver in risky scenarios. c) Risky situations dividing / focusing attention of driver d) Defensive Driving. e) Assessment provided in city / country drive mode in risky situation. f) Random customization of risky scenarios. g) Collision avoidance.
15	Night driving module	This module relates to different aspects of night driving & related traffic rules. Training module should help learners to refine his/her perceptions on maintaining appropriate speed & distance in night and on making right use of vehicle lights & low/ high beam operations under varied traffic situations as follows: a) Basics of night driving b) Crossing a vehicle c) Being passed by surrounding vehicles d) Passing surrounding vehicles e) Pedestrians & other movements in night f) Review
16	Emergency braking & response time	This section should make the driver realize an emergency braking action in varied dangerous situations. Under each braking action, response / reaction time of driver should be captured with allied driving parameters. a) Random braking action in different road conditions & braking modes. i) Dry Road ii) Wet Road iii) Icy Road

Sl. No.	Features	Description
		iv) Conventional brakes v) ABS applications b) Sudden braking action test at stop signal should predict driver behaviour on following parameters. i) Speed ii) Reaction time iii) Reaction distance iv) Braking distance v) Stopping distance vi) Deceleration c) Braking action test under simple / complex dangerous situations should capture driver behaviour on following parameters. i) Speed ii) Reaction time iii) Stopping distance iv) Speed at collision v) Missing space cushion vi) Reaction distance vii) Braking distance d) 2 second rule test on depth perception / braking application.
17	Eco driving module	This module should have provision for giving indicative fuel consumptions and pollution results of driver before learning eco driving principles and afterwards, when he/she uses these skills. The results should capture following elements. a) Fuel consumption b) CO_2 emission c) Nitrogen oxide d) CO e) Hydrocarbons f) PM particles g) Fuel savings h) Accident reduction ratios Simulator is to provide step by step techniques to improvise on greenhouse gas emission norms & in achieving improvised fuel economies under following structured eco driving principles: a) Use of engine at the best b) How to accelerate c) Managing the right speed d) Going through lights e) Up-hill / Down-hill driving f) Stopping the vehicle g) The art of parking h) Pre drive checks

Sl. No.	Features	Description
18	Free driving module	Under this module, learner should get an opportunity to configure his/her driving scenario as per his/her requirements & training needs. He/ She should go through the configured driving session & get feedback at the termination of that particular session. Free drive should give option to choose the environment on following variabilities : a) Free drive through simulated modes of day. Simulator to give provision to drive / practice in different simulated modes of day as stated below: i) Day drive ii) Dusk drive iii) Night drive b) Free drive through varying traffic densities. Simulator to give provision to drive / practice in three varying traffic density as stated below: i) Slow traffic ii) Medium traffic iii) High traffic c) Free drive through adverse weather conditions. Simulator to give provision to drive / practice in adverse weather conditions as stated below: i) Low visibility ii) Medium visibility iii) Low fog visibility d) Driving in rain: i) Low rain ii) Medium intensity rain iii) High intensity rain e) Varied driving positions: i) City Centre ii) Outskirts of city iii) Highway iv) Hilly road v) Mountain road f) Driving feedback provided at the end of each driving session should be configured on aforesaid parameters.
19	Assessment Module (Optional / customized)	Assessment module should be customized for objective skill evaluation of drivers broadly covering following behavioural aspects of driving training. Feedback of trainee should be obtained in print form after the completion of his driving session. The vendor may need to understand customer perception better before evolving some of the skill evaluation parameters as marked with asterisk. a) Action / reaction analysis i) Under simple situations ii) Under complex situations b) Analysis on violation of Traffic Signals and Rules

Sl. No.	Features	Description
		c) Random free drive analysis / feedback i) Driving time ii) Seatbelt not fastened iii) Insufficient separation gap iv) Incorrect use of signals v) Road marking or white line errors vi) Inappropriate actions at junctions vii) Speed over permissible limit viii) Lane discipline ix) Not following instructions x) Collisions d) Depth perception test* i) 2 second rule analysis e) Peripheral vision test* i) Side view vision ii) Rear view vision f) Driver aptitude test
B)	**TRAINING MODULES**	
1	Progressive Training for Driving skills	The training options include 2 modules viz animation based Theoretical training and Practical training (simulator based training)Progressive training modules as follows should cover comprehensive training curriculum for Drivers with License starting from acquiring basics to advanced driving skills are developed on an actual city terrain and not test tracks for realistic driving feel. • Training Modules – For Novice Driver and Trained Driver • Defensive Driving Module (City, Hill & Highway) • Fuel Efficiency Module
2	Defensive Driving Test	A module that tests the driver on his/her defensive driving skills. He/She should encounter more than 30 risky scenarios while driving this module.
3	Fuel Efficiency Module	A Module that will test the Driver on Fuel Consumption minute by minute. The Module should take into account the various aspects of driving and give the driver a graphical & tabular report on his/her performance.
4	Performance Evaluation & Report Generation	Simulator is to evaluate the driver throughout the training process. The evaluation criteria are as per Motor Vehicle Act and Rules of Road Regulations standards in India A printed report is to be generated at the end of each session. The system should also produce and print a consolidated report of the drivers' entire training period. Graphical & Tabular reports are to be generated at the end of each session.
5	Training Cues	These are written and vocal messages of basic rules for habitual safe driving. Training cues should be available in English.
6	Others	1. The training includes audio visual tutorials which shall be in English. 2. Trainee assessment should comprised of 2 modules i.e., Driver Aptitude

Sl. No.	Features	Description
		Test (CBT based evaluation containing MCQs) and Simulator based Test (Scenario based) 3. In addition to the rule based assessment of the driver's performance, assessment also capture lapses committed by the driver
C)	**INSTRUCTOR STATION FEATURES**	
1	Customized Scenario settings	The instructor station should enable the instructor to customize the following in various combinations: • Selection of routes • Daylight conditions • Weather conditions • Traffic density
2	Calibration of the vehicle	The instructor station should enable unlimited calibration of the following controls for easy self maintenance: • Steering • Brake • Accelerator • Clutch
3	Diagnostics of Controls	This feature should enable the instructor to Diagnose the controls of the simulator in case of a system breakdown for easy maintenance.
4	Record and Replay	All the Driving Sessions of the User are to be recorded and have provision to be replayed.